

CONTENTS

Host Chapter: Dallas	x
Program Committee and Transactions Staff	x
State of the Society Report by H.E. "Barney" Burroughs	xi
Plenary Address by Robert F. Overmyer	xv
Abstracts	xix

TECHNICAL PAPERS

FIRST TECHNICAL SESSION

3112	Humidity, Comfort and Contact Lenses by J.E. Laviana, F.H. Rohles, Jr., and P.E. Bullock	3
3113	Rationalization of the Effective Temperature ET*, as a Measure of the Enthalpy of the Human Indoor Environment by A.P.R. Fobelets and A.P. Gagge	12
3114	Clothing Insulation Asymmetry and Thermal Comfort by B.W. Olesen, Y. Hasebe, and R.J. de-Dear	32

SECOND TECHNICAL SESSION

3115	Airflow Characteristics in the Occupied Zone of Heated Spaces without Mechanical Ventilation by A.K. Melikov, H. Hanzawa, and P.O. Fanger	52
3116	Determination of the Effect of Walking on the Forced Convective Heat Transfer Coefficient Using an Articulated Manikin by S.K.W. Chang, E. Arens, and R.R. Gonzalez	71
3117	Effect of Behavioral Strategies and Activity on Thermal Comfort of the Elderly (RP-460) by K.M. Cena, J.R. Spotila, and E.B. Ryan	83
3118	Examination of Free Convection around Occupant's Body Caused by Its Metabolic Heat by H. Homma and M. Yakiyama	104

THIRD TECHNICAL SESSION

3119	A Method for Characterizing the Dynamic Performance of Wall Specimens Using a Calibrated Hot Box by D.M. Burch, R.R. Zarr, and B.A. Licitra	125
3120	Surface Heat Flow in Solid Spheres with Time-Dependent Inputs by T. Ceylan	141
3121	Evaporation and Condensation of Refrigerant-Oil Mixtures in a Smooth Tube and a Micro-fin Tube (RP-469) by L.M. Schlager, M.B. Pate, and A.E. Bergles	149
3122	Measuring the Concentration of a Flowing Oil Refrigerant Mixture: Instrument Test Facility and Initial Results (RP-356) by J.J. Baustian, M.B. Pate, and A.E. Bergles	167

FOURTH TECHNICAL SESSION

3123	A Study of the Filling of Wall Cavities with Retrofit Wall Insulation by J.A. Flores and A.R. Grill	178
3124	Life-Cycle Cost Analysis of Variable-Speed Pumping for Coils Application by O. Ahmed	194
3125	An Overview of 3-D Graphical Analysis Using DOE-2 Hourly Simulation Data by J. Haberl, M. MacDonald, and A. Eden	212
3126	Thermally Induced Pressure Distribution in Simulated Tall Buildings with Floor Partitions by K.H. Lee, H. Tanaka, and Y. Lee	228
3127	Correlations for Pressure Distribution on Buildings and Calculation of Natural-Ventilation Airflow by M.V. Swami and S. Chandra	243

FIFTH TECHNICAL SESSION

3128	Design Considerations for Fixed-Bed Metal Hydride Heat Pumps for High-Temperature Boosts by M.R. Ally	267
3129	Experimental Evaluation of Three Ground-Coupled Heat Pump Systems by R.R. Johnson, J.A. Edwards, J.C. Mulligan, Y. Mohammadzadeh, and P. Safemazandarani	280
3130	Laboratory Testing of a Heat Pump System with Water-to-Water, Counterflow Heat Exchangers Using Various Compositions of an R13B1/R152a Nonazeotropic Refrigerant Mixture by E.A. Vineyard	292
3131	Performance of Heat Pump Reversing Valves and Comparison through Characterizing Parameters by G.D.S. Damasceno, W.N.T. Lee, S.P. Rooke, and V.W. Goldschmidt	304
3132	Performance Test of a Direct Expansion Heat Pump System by J.A. Edwards, P. Safemazandarani, R.R. Johnson, and Y. Mohammadzadeh	318

SIXTH TECHNICAL SESSION

3133	Energy Rating of Refrigerators with Variable Defrost Controls by B.M. Mahajan	330
3134	The Prospect of Incorporating Desuperheaters to Room Air-Conditioners for Tropical Application by T.Y. Bong, M.N.A. Hawlader, and W. Mahmood	340
3135	Experimental Study of Internal Flow of a Room Air Conditioner Incorporating a Cross Flow Fan by K. Matsuki, Y. Shinobu, A. Takushima, and S. Tanaka	350
3136	Evaluation of Performance Degradation Due to Inlet Elbow Orientation on a Small Forward-Curved Centrifugal Fan by D.L. O'Neal and N.Y. Chan	365

SEVENTH TECHNICAL SESSION

3137	Comparison Testing of Solar Water-Heating Systems: Difficulties and Solutions by T.F. Tiedemann	375
3138	Performance of Sunspaces in Northern Climates by P.R. Burns and R.A. O'Neil	381
3139	Evaporator Performance of Two-Phase Thermosiphon Loop Heat Exchanger under Constant Heat Flux Boundary Conditions by G.D. Mathur and T.W. McDonald	404
3140	Energy Consumption and Economic Evaluation of Thermal Storage and Recovery Systems for a Large Commercial Building by B.F. Gray, C.A. Johnson, G.J. Schoenau, and R.W. Besant	412
3141	A Study of Solar Insolation—Reno, Nevada, 1979-1985 by R.B. McKee, J.D. Arends, C.V. Eggstaff, and S.C. Peterson	425

EIGHTH TECHNICAL SESSION

3142	A Comprehensive Method of Improving Part-Load Air Conditioning Performance by A. Shaw and R.E. Luxton	442
3143	Refrigerant Leakage in Heat Pump Reversing Valves Including Comparison to Air Leakage Measurements by W.N.T. Lee, G.D.S. Damasceno, V.W. Goldschmidt, and R.T. Marks	458
3144	A Model of an Ammonia-Water Falling Film Absorber by H. Perez-Blanco	467
3145	Refrigerant Flow through Orifices by K.I. Krakow and S. Lin	484
3146	A Correlation of Experimental Exit Pressures for Refrigerant Flow through a Capillary Tube Expansion Device by U.W. Schulz	507

SYMPOSIUM PAPERS

DA-88-1 STATE-OF-THE-ART DESICCANT COOLING APPLICATIONS

Application of Gas-Fired Desiccant Cooling Systems by B.M. Cohen and R.B. Slosberg	525
Desiccant Cooling R&D in Japan by K. Matsuki and Y. Saito	537
Assessment of Thermally Activated Heat Pumps with Desiccant Cooling by R.H. Turner, J.D. Kleiser, R.F. Chen, N. Domingo, and F. Chen	552
DUBLSORB—A Universal Desiccant Hybrid Approach by W.H. Wilkinson, D.K. Landstrom, and D. Novosel	563
Off-Peak Desiccant Cooling and Cogeneration Combine to Maximize Gas Utilization by M. Meckler	575

DA-88-2 BUILDING OPERATION DYNAMICS: APPLICATIONS AND CASE STUDIES

Dynamic Control: Fundamentals and Considerations by T.B. Hartman	599
Calculating Optimum Filter Change Intervals by K.M. Elovitz	610
Investigation of Control Alternatives for a Steam Turbine Driven Chiller by S.A. Klein, D.R. Nugent, and J.W. Mitchell	627
Test Hut Validation of a Microcomputer Predictive HVAC Control by M.M. Shapiro, A.J. Yager, and T.H. Ngan	644

DA-88-3 THE ROLE OF AIR DIFFUSION IN VENTILATION EFFECTIVENESS

Throw: The Air Distribution Quantifier by D. Int-Hout, III, and J.B. Weed	667
Spot Cooling/Heating and Ventilation Effectiveness by C.E. Brown	678
A Quantitative Evaluation of Air Distribution in Full Scale Mock-Ups of Animal Holding Rooms by M.D. McDiarmid	685
Ventilation Effectiveness and ADPI Measurements of a Forced Air Heating System by F.J. Offermann, III	694

DA-88-4 LARGE HEAT PUMPS FOR DISTRICT HEATING AND COOLING

Absorption Heat Pumping for District Heating Now Practical by W.F. Davidson and D.C. Erickson	707
Operating Experience with a 50 MW Absorption Heat Pump by L.E. Astrand	716
Significance of Operating-Mode Flexibility in a District Heat Pump System by G. Meckler	723
The Energy "Amenity": Heat Pumps Serve District Heating in Treatment Plant Energy Programs by D.L. Schneider and J.O. Goss	741
District Heating and Cooling with Heat Pumps Outside the United States by J.M. Calm	754

DA-88-5 MEASUREMENT AND PREDICTION OF DAYLIGHT AND ENERGY IMPACTS IN SELECTED ATRIUM TYPES

Empirically Based Algorithms for Preliminary Prediction of Daylight Performance in Toplighted Atriums by L.L. Boyer and K.S. Kim	765
Daylight Prediction and Measurement for Three-Sided Multistory Atriums under Overcast and Clear Skies by K.S. Kim and L.L. Boyer	783

	Computer Prediction and Measurement Comparison of Daylighting Performance in Selected Atrium Buildings Using the SERI Algorithms by L.L. Boyer and M.S. Oh	799
	Integrated Daylighting, Heating, and Cooling Model for Atriums by L.O. Degelman, J.F. Molinelli, Jr., and K.S. Kim	812
	The Daylighting and Thermal Performance of Roof Glazing in Atrium Spaces by G.L. Gillette and S. Treado	826
DA-88-6	LABORATORY ANALYSIS AND FIELD TESTING OF UNITARY HEAT PUMPS	
	Monitoring of Residential Groundwater-Source Heat Pumps in the Northeast by G.M. Freedman and R.S. Dougall	839
	Field Test of a Novel Bivalent Heat Pump to Establish Heating Demand and Load Profiles by D.F. Cuthbert	864
	Laboratory Efficiency Comparisons of Modulating Heat Pump Components Using Adjustable Speed Drives by W.A. Miller	874
	Efficiency Characteristics of Speed-Modulated Drives at Predicted Torque Conditions for Air-to-Air Heat Pumps by C.K. Rice	892
DA-88-7	INTERNATIONAL SYMPOSIUM ON DESIGN OF INTELLIGENT BUILDINGS	
	The Intelligent Building—An ASHRAE Opportunity by R.J. Caffrey	925
	Modern Building Services—More than Computerized HVAC by A.D. McKinley	934
	A Building with Variable Thermal Performances by B.D. Todorovic, M. Mitric, and M. Ligeti	948
	Artificial Intelligence in Building Control Systems by J.D. Petze and D.R. Reed	960
DA-88-8	THE ROLE OF DIAGNOSTIC MEASUREMENTS IN ENERGY PERFORMANCE MONITORING	
	Instrumentation Applications for Commercial Building Energy Audits by H.P. Misuriello	973
	Diagnostic Techniques for Evaluating Office Building Envelopes by A.K. Persily, R.A. Grot, J.B. Fang and Y.M. Chang	987
	In-situ Appliance Efficiency Audit Procedures by R.F. Szydlowski and P.G. Cleary	1007
	Alternatives for Monitoring Multidwelling Energy Measures by J.M. Porterfield	1024
DA-88-9	APPLICATIONS OF KNOWLEDGE-BASED SYSTEMS IN THE HVAC INDUSTRY	
	An Expert System for Building Energy Consumption Analysis: Applications at a University Campus by J.S. Haberl, L.K. Smith, K.P. Cooney, and F.D. Stern	1037
	Knowledge Engineering for HVAC Expert Systems by P.W. Brothers	1063
	Knowledge-Based Front-End Input Generating Program for Building System Simulation by S.T. Liu and G.E. Kelly	1074
DA-88-10	HOT WATER USAGE RATES, NEW INFORMATION AND ENERGY CONSERVATION	
	Hot Water and Energy Use in Apartment Buildings by M. Perlman and N.H. Milligan	1087
	Residential Hot Water Use in Florida and North Carolina by T.J. Merrigan	1099
	Residential Water Heater Electrical Usage and Demand Reduction Using Reduced Element Sizes and Time Clock Controls by D.G. Colliver, W.E. Murphy, and J.L. Taraba	1110
DA-88-11	OVERVIEW OF RESEARCH ACTIVITIES ON WOOD BURNING EQUIPMENT	
	Control of Thermal Output, Stack Gas Emissions, and Indoor Air Quality Influences for Conventional and Catalytic Wood Heaters by C.V. Knight	1125
	Secondary Combustion in a Dual-Chamber Woodstove by G.A. Spolek, R.E. Hall, and J.H. Wasser	1138
	In Situ Wood Heat Monitoring: Evaluation of Measured Heat Output and Field Efficiency by R.A. Yoder, M.P. Modera, and G.A. Spolek	1147
	Reducing Emissions from Wood Stoves by Reducing Wood Surface Area by M.P. Modera and F. Peterson	1154
DA-88-12	NEW TRENDS IN HOSPITAL VENTILATION	
	Control of Microbioaerosol Contamination in Critical Areas in the Hospital Environment by W.W. Rhodes	1171
	Ventilation for Protection of Immune Compromised Patients by W.A. Murray, A.J. Streifel, T.J. O'Dea, and F.S. Rhame	1185
	Application of VAV, DDC, and Smoke Management to Hospital Nursing Wards by J.R. Lewis	1193
DA-88-13	SMOKE CONTROL TECHNOLOGY	
	An Overview of Smoke Control Technology by J.H. Klote	1211
	Pressure Drop Characteristics of Typical Stairshafts in High-Rise Buildings by G.Y. Achakji and G.T. Tamura	1223
	Information-Based Smoke Control Systems by G. Shavit	1238
	Fire Department Application of Positive Pressure Ventilation by B.G. Roberts	1253
DA-88-14	COMMERCIAL AND INDUSTRIAL SOLAR APPLICATIONS	
	Five-Year Performance Results for the Dallas-Fort Worth (DFW) Airport Solar Total Energy System by M.J. O'Neill	1261
	Corrosion, Toxicity, and Freeze Characteristics of Uninhibited Degraded Propylene Glycol for Use in Closed Loop Active Solar Systems by J.G. Avery	1271
	Site-Built Large Volume Solar Water Heating Systems for Commercial and Industrial Facilities by H.M. Healey	1277
DA-88-15	INTERNATIONAL SYMPOSIUM ON ENERGY MANAGEMENT	
	Passive Solar Energy in Intelligent Buildings by A.H.C. van Paassen	1289
	Methodology for Guidance of Power Supply in Urban Areas by D. Corak and Z. Muzek	1297
	The Optimal System Choice to Provide the Energy Needs of a Large Industrial Complex by E.S. Kulic, S. Sirbubalo,	

M. Osmanagic, D. Momcinovic, and T. Sadovic	1307
Intelligent Buildings—Smarter with DDC by V.A. Williams	1314
DA-88-16 MODELING IN DIVERSE ENVIRONMENTS	
Comparison of Thermal Predictive Models for Clothed Humans by W.A. Lotens	1321
An Evaluation of Computer-Based Models that Predict Human Responses to the Thermal Environment by R.A. Haslam and K.C. Parsons	1342
Rational Considerations for Modeling Human Thermoregulation during Cold Water Immersion by P. Tikuisis and R.R. Gonzalez	1361
Evaluation of the Physiological Bases of Thermal Comfort Models by T.J. Doherty and E. Arens	1371
Modeling of Human Performance in Hyperbaric Environments by E.H. Wissler	1386
DA-88-17 COOLING OF FRUITS AND VEGETABLES: NEW INNOVATIONS AND ECONOMIC EVALUATIONS	
Night Picking of Fruits and Vegetables to Reduce Cooling Load by W.C. Fairbank	1403
Cooling of Strawberries in Cartons with New Vent Hole Designs by B.B. Arifin and K.V. Chau	1415
Comparative Energy Use of Vacuum, Hydro, and Forced Air Coolers for Fruits and Vegetables by J.F. Thompson and Y.L. Chen	1427
Design Criteria for Efficient and Cost Effective Forced Air Cooling Systems for Fruits and Vegetables by C.D. Baird, J.J. Gaffney, and M.T. Talbot	1434
DA-88-18 THE VAV OUTSIDE AIR ECONOMIZER CYCLE	
Selecting and Sizing Outside and Return Air Dampers for VAV Economizer Systems by R.L. Alley	1457
The Economics of Relief Fans Vs. Return Fans in Variable Volume Systems with Economizer Cycles by C.C. Kalasinsky	1467
Field Problems Associated with Return Fans on VAV Systems by J.P. Kettler	1477
Decoupling Supply and Return Fans for Increased Stability of VAV Systems by L.H. Alcorn and P.J. Huber	1484
VAV System Interactive Controls by V.A. Williams	1493
DA-88-19 APPLICATION SPECIFIC CONTROLS: WHERE DO THEY FIT IN?	
What Distributed Microcontrollers Bring to the Building Management System by P.P. Payne	1503
HVAC Controls in Laboratories—A Systems Approach by C.P. Andersen and K.M. Cunningham	1514
Building a Control System from the Bottom Up Using Application-Specific Controllers by J.R. Sosoka and K.W. Peterson	1521
Versatile Application-Specific Controllers for Hotel Guest Rooms by S.A. Muxen and W.F. Chapman	1530
DA-88-20 MATHEMATICAL MODELING AND EXPERIMENTAL STUDIES ON TRANSPIRATION FROM FRUITS, VEGETABLES, AND MUSHROOMS	
A Mathematical Model for the Transpiration from Fruits and Vegetables (RP-370) by K.V. Chau, J.J. Gaffney, and R.A. Romero	1541
Transpiration Coefficients for Certain Fruits and Vegetables (RP-370) by K.V. Chau, R.A. Romero, C.D. Baird, and J.J. Gaffney	1553
Effects of Temperature, Relative Humidity and Storage Time on the Transpiration Coefficients of Selected Perishables (RP-442) by P.N. Patel, T.K. Pai, and S.K. Sastry	1563
Effects of Temperature Fluctuation on Transpiration of Selected Perishables: Mathematical Models and Experimental Studies (RP-442) by P.N. Patel and S.K. Sastry	1588
DA-88-21 BUILDING ENERGY COGENERATION SYSTEMS ANALYSIS	
Modeling Cogeneration Systems with DOE-2.1C by J.H. Eto and S.D. Gates	1605
A Microcomputer Version of a Large Mainframe Program for Use in Cogeneration Analysis by D.C. Pedreyra	1617
The Use of Detailed Simulation for the Study of the Feasibility of Cogeneration at a University Campus by G.R. Guinn	1626
Second Law Efficiency and Costing Analysis of a Total Energy Plant by R.A. Gaggioli, L. Wang, K.-X. Zhu, and J.R. Too	1642
DA-88-22 DESIGN AND PERFORMANCE OF WATER LOOP HEAT PUMP SYSTEMS	
Energy Requirements for Closed Loop Storage Heat Pump Systems with Different Internal Loads for Various Geographic Locations by R.H. Howell	1679
Performance Monitoring Results for Office Building Groundwater Heat Pump System by M.J. Brown, B.J. Hesse, and R.A. O'Neil	1691
Case History—Low-Rise Office Building Using Water-Source Heat Pump by E.E. Friberg	1708
DA-88-23 BUILDING OPERATION DYNAMICS: INNOVATIVE ANALYSIS, SIMULATION, AND CONTROL TECHNIQUES	
Global Optimization of HVAC System Operations in Real Time by Z. Cumali	1729
Thermal Response of Houses Resulting from Heating and Cooling Interruptions by G.F. Boufadel and W.C. Thomas	1745
POST: Plant Operations Simulation Template by D.R. Clark and G.E. Kelly	1760
Use of a General Control Simulation Program by X. Zhang and M.L. Warren	1776

DA-88-24 RADIANT HEATING AND COOLING

Development of a Radiant Heating System Model for BLAST by D.M. Maloney, C.O. Pedersen, and M.J. Witte . .	1795
Angle Factor Determination from a Person to Inclined Surfaces by M. Steinman, L.N. Kalisperis, and L.H. Summers	1809
A Method for Testing Hydronic Radiant Metal Ceiling Panels by B.M. Osojnak and R.F. Boehm	1824
Radiant Cooling in Laboratory Animal Caging by R.B. Hayter and R.L. Gorton	1834
Case Studies Support Adjusting Heat Loss Calculations When Sizing Gas-Fired Low-Intensity Infrared Equipment by N.A. Buckley and T.P. Seel	1848

DA-88-25 ECONOMICS OF COOL STORAGE

French Office Tower Pioneers with Thermal Storage by B. Cordailat and R.T. Tamblyn	1861
Thermal Storage Retrofit Restores Dual Temperature System by G.V.R. Holness	1866
Ice Storage Application to an Illinois Hospital by D.L. Grumman and A.S. Butkus, Jr.	1879
Economics of Harvesting Thermal Storage Systems: A Case Study of a Merchandise Distribution Center by D.E. Knebel	1894
Economics of Ice Storage Systems in a University Engineering Building by J.M. Ayres and H. Lau	1905

DA-88-26 INTERNATIONAL SYMPOSIUM ON COGENERATION IN DISTRICT HEATING AND COOLING

Cogeneration and Heat Pumps in Combination with Thermal Storage by P.J. Collet	1933
Conversion of an Electric Power Plant in Des Moines to Cogeneration and District Heating by R.M. Nelson and E.O. Kainlauri	1947
Hospital Complex as a Base for District Heating by W.A. Smith	1957

DA-88-27 NEW DEVELOPMENTS IN COOL STORAGE

Thermal Energy Storage With Encapsulated Ice by D.R. Laybourn	1971
The Use of Direct Pumping and Hydraulic Turbines in Thermal Storage Systems by R.K. Tackett	1989
Cold Air Distribution by C.E. Dorgan and J.S. Elleson	2008

DA-88-28 DEVELOPMENTS IN HVAC EDUCATION

The Water Source Heat Pump as a Multiple Experiment HVAC Laboratory by S.P. Kavanaugh	2029
Suggested Laboratory Experiments to Support HVAC Education by H. Singh and P. Rojeski	2043
User Assisted Duct Design and Fan Sizing for HVAC Classes by W.E. Murphy	2054
A Methodology for Implementing a Psychrometric Chart in a Computer Graphics System by Z. Zhang and M.B. Pate	2069

SOCIETY BUSINESS

ASHRAE Officers, Directors, Committeemen and Staff	2081
ASHRAE Chapter Officers	2084
ASHRAE Past Meetings	2086
Society Presidents	2087
ASHRAE Honors and Awards	2088
ASHRAE Intersociety Representatives	2094
ASHRAE International Associates	2095
Index of Technical and Symposium Papers, Volume 94, Part 1	2097